Small Business Innovation Research/Small Business Tech Transfer

Autonomous Modular Digital Controllers for Long Duration Space Flights, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

An intelligent power management and distribution system is an essential component of future NASA long duration flights in deep space. The current power management system for manned NASA missions in lower earth orbit depends heavily on operators in the ground control center. As mankind ventures into deep space, the existing Power Management and Distribution (PMAD) system will not be able to respond fast enough for ever-changing power requirements in the harsh deep space environment.

The proposed innovation is an autonomous digital-hardware controller with built-in Active Disturbance Rejection Controls (ADRC) for long duration deep space flights. The proposed Autonomous Modular Digital Controller (AMDC) provides high efficient, reliable, fault-tolerant, and intelligent power management for deep space missions.

The following are the relevance and significance of the proposed innovation to the subtopic S3.03:

- Autonomous local power management to improve system reliability.
- Built-in active disturbance rejection controls for system robustness.
- Active switching frequency control to improve power quality.
- Multi-functional operation configurations to reduce mass/volume.
- Self-diagnostic and fault/limit recording for fault-tolerant operations.

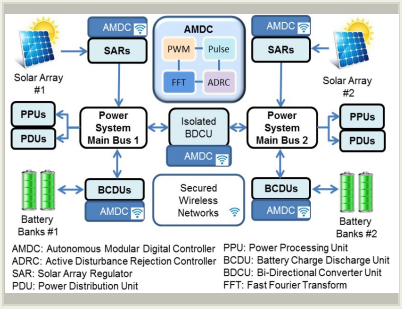
The current state of art technologies for controlling power electronic switching devices is using mixed analog and digital controls with fixed controller gains. A few of existing all digital controls are microprocessor based controls with a single-thread software written by C programming language. The proposed AMDC utilizes the parallelism of the Field Programmable Gate Array (FPGA) to implement high-speed, multi-threads, all digital hardware, register-based state machines, and intelligent gain controls with active disturbance rejections.

There are many current and future potential NASA applications for the AMDC controlled PMAD systems.

Anticipated Benefits

1. Space Vehicle Power Management and Distribution (PMAD) System: to provide stable, clean, and reliable power to the associated on-board systems.

2. Scientific Researches Missions in Deep Space: having the AMDC system can



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help speed up development of future deep space propulsion.

3. All Electrical Airplane: AMDC provide efficient and safe method of powering the drive and life-support systems.

4. Unmanned air vehicles: AMDC allows true UAV applications with autonomous PMAD system.

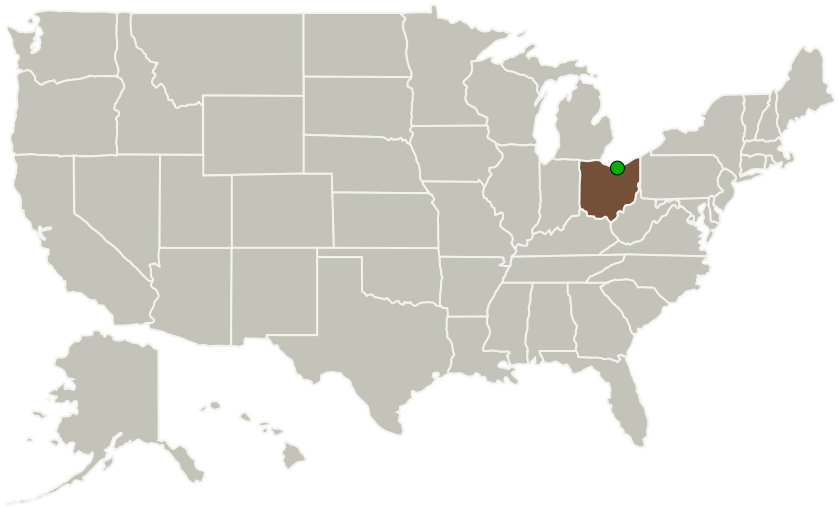
1. High Efficiency Renewable Energy: the AMDC will have the basic building blocks to convert renewable energy.

2. Aerospace and Defense: AMDC is ideal to manage complex electrical systems.

3 Medical Power Systems: The fault tolerant and stability of AMDC would allow modules to be used in life-critical applications.

4 Large Servers and Computer Data Centers: AMDC can benefit power critical systems such as server farms, scientific systems, and supercomputers.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

AK Circuit Corporation

Responsible Program:

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Project Management

Program Director:

Jason L Kessler

Program Manager:

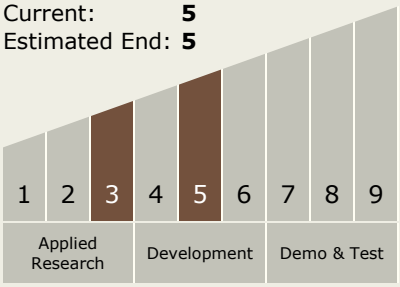
Carlos Torrez

Principal Investigator:

Michael Sammartino

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



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Organizations Performing Work	Role	Type	Location
AK Circuit Corporation	Lead Organization	Industry	Canfield, Ohio
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations
Ohio

Project Transitions

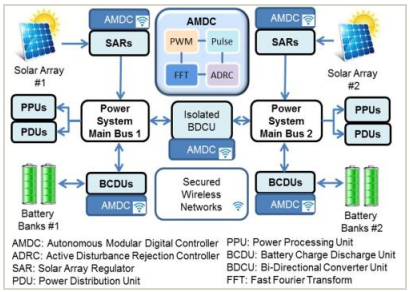
July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140947)*

Images



Briefing Chart Image
Autonomous Modular Digital Controllers for Long Duration Space Flights, Phase I
(https://techport.nasa.gov/image/136912)

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.3 Power Management and Distribution
    - TX03.3.1 Management and Control

Target Destinations

Earth, The Moon, Mars

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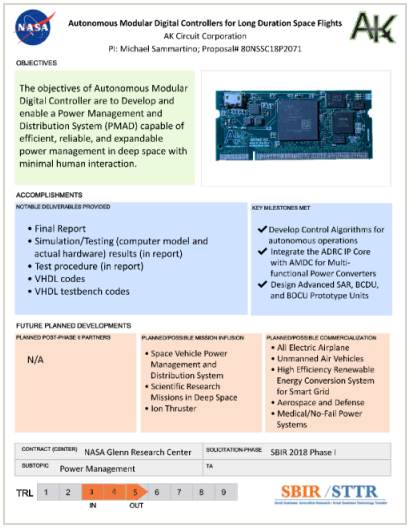

Final Summary Chart Image
Autonomous Modular Digital Controllers for Long Duration Space Flights, Phase I
(https://techport.nasa.gov/image/126256)